

# PATENT COOPERATION TREATY

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PCT

## NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Assistant Commissioner for Patents  
United States Patent and Trademark  
Office  
Box PCT  
Washington, D.C. 20231  
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 01 September 2000 (01.09.00)	
International application No. PCT/GB99/03966	Applicant's or agent's file reference P2513.PC/DCC
International filing date (day/month/year) 29 November 1999 (29.11.99)	Priority date (day/month/year) 29 January 1999 (29.01.99)
Applicant DAVEY, Terence, James	

1. The designated Office is hereby notified of its election made:



in the demand filed with the International Preliminary Examining Authority on:

16 August 2000 (16.08.00)



in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was



was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

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NOV - 9 2000  
TO 1700 MAIL ROOM

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer Zakaria EL KHODARY
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

Form PCT/IB/331 (July 1992)

GB9903966

## PATENT COOPERATION TREATY

## PCT

REC'D 09 MAY 2001

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## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

14

Applicant's or agent's file reference P2513.PC/DCC	<b>FOR FURTHER ACTION</b>	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/GB99/03966	International filing date (day/month/year) 29/11/1999	Priority date (day/month/year) 29/01/1999
International Patent Classification (IPC) or national classification and IPC B29C73/26		
Applicant DAVEY, Terence, James		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 8 sheets, including this cover sheet.



- ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 4 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☒ Certain observations on the international application

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JUL 11 2001  
TC 1700

Date of submission of the demand 16/08/2000	Date of completion of this report 07.05.2001
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Golombek, G Telephone No. +49 89 2399 2909 

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB99/03966

## I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

### Description, pages:

1,3-10	as originally filed		
2	as received on	21/12/2000	with letter of 15/12/2000

### Claims, No.:

1-16	as received on	21/12/2000	with letter of 15/12/2000
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### Drawings, sheets:

1/2,2/2	as originally filed
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2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB99/03966

- ☐ the description, pages:  
☒ the claims, Nos.: 17,18  
☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

## V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

### 1. Statement

Novelty (N)	Yes:	Claims	1-16
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-16
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-16
	No:	Claims	

2. Citations and explanations  
**see separate sheet**

## VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:  
**see separate sheet**

## VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:  
**see separate sheet**

**T point V**

**Claim 1**

Document D1 = US-A-3 837 965 discloses a method of treating a surface layer of a product which is made of a material which has or materials which have been applied to a surface in a liquid form and thereafter have dried or cured to make the product ready for use, wherein a repair patch is secured to a damaged surface, wherein:

- the edges of a sheet of impermeable material is secured to a surface of the product to be repaired to enclose a space between the surface and the sheet,
- heating is applied within the space;
- the gaseous contents of the space is continuously extracted while the sheet is spaced from the surface to allow gas and vapour to be extracted from any area of the surface beneath the sheet.

D1 and the other documents of the search report is quiet about, that there is no necessity of covering the damaged surface by a repair patch.

Furthermore, there is no hint for a person skilled in the art to omit this repair patch.

Thus, the subject-matter of claim 1 is new and industrially applicable and it involves an inventive step and the claim itself meets the requirements of Article 33 PCT.

**Claims 2 - 9**

These dependent claims disclose preferred embodiments of the method claimed.

**Claim 10**

Document D1 = US-A-3 837 965 discloses a method of treating a surface layer of a product moulded from fibre reinforced plastics, wherein:

- the edges of a sheet of impermeable material is secured to a surface of the product to be treated to enclose a space between the surface and the sheet,
- heating is applied within the space;

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT - SEPARATE SHEET**

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International application No. PCT/GB99/03966

- the gaseous contents of the space is continuously extracted while the sheet is spaced from the surface to allow gas and vapour to be extracted from any area of the surface beneath the sheet.

D1 and the other documents of the search report are quiet about, that:

- there is no necessity of covering the damaged surface by a repair patch;  
and
- that the method is used to repair a boat hull.

Furthermore, there is no hint for a person skilled in the art to omit this repair patch.

Thus, the subject-matter of claim 10 is new and industrially applicable and it involves an inventive step and the claim itself meets the requirements of Article 33 PCT.

**Claim 11**

Document D1 discloses an apparatus for treating a product made of a material which has or materials which have been applied to a surface in a liquid form and thereafter have dried or cured to make the product ready for use, the apparatus comprising an impermeable sheet, means for securing the sheet to a surface of the product to be treated to enclose

a space between the surface and the sheet, means for holding the sheet spaced from the surface to allow gas and vapour to be extracted from any area of the surface beneath the sheet, heating means for applying heat within the space and means for continuously extracting the gaseous contents of the space.

D1 and the other documents of the search report are quiet about, that there is no necessity of means for covering the damaged surface by a repair patch;

Furthermore, there is no hint for a person skilled in the art to omit this repair patch.

Thus, the subject-matter of claim 11 is new and industrially applicable and it involves an inventive step and the claim itself meets the requirements of Article 33 PCT.

#### **Claims 12 - 16**

These dependent claims disclose preferred embodiments of the apparatus claimed.

#### **Claim 16 (independent claim)**

Document D1 discloses a method of treating a product moulded from fibre reinforced plastics, wherein impermeable sheet material is secured to a surface of the product to be treated to enclose a space between the surface and the layer, heating is applied within the space, and the gaseous contents of the space are continuously extracted.

D1 and the other documents of the search report are quiet about, that there is no necessity of covering the damaged surface by a repair patch.

Furthermore, there is no hint for a person skilled in the art to omit this repair patch.

Thus, the subject-matter of claim 16 is new and industrially applicable and it involves an inventive step and the claim itself meets the requirements of Article 33 PCT.

**To point VII**

There are two claims having the number 16 being contrary to Rule 6.1 b) PCT.

**To point VIII**

- 1 Claims 1, 10, 11 and 16 have been drafted as separate independent claims, they appear to relate effectively to the same subject-matter and to differ from each other only with regard to the definition of the subject-matter for which protection is sought and in respect of the terminology used for the features of that subject-matter. The aforementioned claims therefore lack conciseness. Moreover, lack of clarity of the claims as a whole arises, since the plurality of independent claims makes it difficult, if not impossible, to determine the matter for which protection is sought, and places an undue burden on others seeking to establish the extent of the protection.

Hence, claims 1, 10, 11 and 16 do not meet the requirements of Article 6 PCT.

- 2 In order to overcome this objection, it would have been appear appropriate to file an amended set of claims defining the relevant subject-matter in terms of a single independent claim in each category followed by dependent claims covering features which are merely optional (Rule 6.4 PCT).
- 3 It is clear from the description on pages 1 and 2 that it is essential to the definition of the invention, that the products to be treated should have a coating layer, which does not become a part of the layers below the surface. Since the feature " material ... applied in liquid form" does not exclude impregnation of layer, a treatment according to claim 1 could lead, when heated too high, to vapourization and extraction of the resin impregnating the glass fibre moulding. This would destroy the product. Since all independent claims do not contain the feature, that the method and the apparatus should be used only to treat a coating layer, e.g. a gelcoat or a plaster these independent claims do not meet the requirement following from Article 6 PCT taken in combination with Rule 6.3(b) PCT that any independent claim must contain all the technical features essential to the definition of the invention.



**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT - SEPARATE SHEET**

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International application No. PCT/GB99/03966

- 4 Furthermore, the independent claims are formulated in such a manner, that the product could consists only of a dried liquid forming a layer without any further layer. Thus the requirements of Article 6 PCT are not fulfilled.

- 2 -

and the fibre/resin layer. The damage can result from one or more of the following: water penetration; degradation reactions resulting from water penetration; deterioration resulting from faulty manufacture; deterioration resulting from faulty materials used in the moulding process; deterioration resulting from failed bonding or de-lamination of foam or timber cores; de-lamination of the moulding. The symptoms of such damage are often attributed to "osmosis" but there is some doubt as to whether any or all of this damage is actually caused by an osmotic reaction.

Conventional treatment is to remove the affected gelcoat to expose the underlying fibre/resin lay-up, to thoroughly dry the exposed fibre/resin lay-up and then when drying is complete to reinstate the gelcoat, possibly with the addition of different resins to provide a better moisture barrier.

This treatment is sometimes, but by no means always, successful. It does however take a considerable amount of time because the resin/fibre lay-up can only be dried slowly, usually by allowing it to stand in the open.

It is known from US 3,837,965 to repair structural damage to eg the skin of an aircraft by applying a patch over the skin at the area to be repaired and then placing a flexible, heated diaphragm over the area where the patch has been applied. Vacuum is created between the diaphragm and the skin which causes the diaphragm to press against the aircraft skin and to apply pressure to the patch to force it against the skin.

According to the present invention, there is provided a method of treating a product moulded from fibre reinforced plastics, wherein the edges of a sheet of impermeable sheet material are secured to a surface of the product to be treated to enclose a space between the surface and the sheet, heating is applied within the space, and the gaseous contents of the space are continuously extracted while the sheet is held spaced from the surface to allow gas and vapour to be extracted from any area of the surface beneath the sheet.

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## Claims

1. A method of treating a product which is made of a material which has or materials which have been applied to a surface in a liquid form and thereafter have dried or cured to make the product ready for use, wherein the edges of a sheet (18) of impermeable sheet material are secured to a surface (10) of the product to be treated to enclose a space between the surface and the sheet, heating is applied within the space, and the gaseous contents of the space are continuously extracted while the sheet is held spaced from the surface to allow gas and vapour to be extracted from any area of the surface beneath the sheet (18).
2. A method as claimed in Claim 1, wherein the impermeable sheet material (18) is secured to the surface (10) by adhesive tape (20) around the edges of the material, so that a space is provided between the impermeable sheet material and the surface.
3. A method as claimed in Claim 1 or Claim 2, wherein the impermeable sheet material (18) has edges which are capable of forming an air tight seal when pulled against the surface (10) by a vacuum.
4. A method as claimed in any preceding claim, wherein a vacuum pump (38) is connected to the space to provide the extraction facility.
5. A method as claimed in any preceding claim, wherein a vacuum is produced in the space before beginning to apply heat within the space.

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6. A method as claimed in any preceding claim, wherein a vacuum at a level of about 2 - 5 mb Abs is produced and maintained in the space.
- 5 7. A method as claimed in any preceding claim, wherein the product is a glassfibre moulding made with a polyester resin and the surface (10) within the space is heated to a temperature of between 80°C and 90°C.
- 10 8. A method as claimed in any preceding claim, wherein the product is a glassfibre moulding with an outer gelcoat and wherein the sheet material (18) is secured to the surface (10) after affected gelcoat, and any physically damaged material has been removed from the surface (10).
- 15 9. A method as claimed in Claim 8, wherein the treatment is completed by replacing removed gelcoat with fresh gelcoat.
- 20 10. A method of treating a boat hull (10) moulded from fibre reinforced plastics, wherein the edges of a sheet (18) of impermeable sheet material are secured to a surface of the hull to be treated to enclose a space between the surface and the sheet, heating is applied
- 25 within the space, and the gaseous contents of the space are continuously extracted while the sheet is held spaced from the surface to allow gas and vapour to be extracted from any area of the surface (10) beneath the sheet (18).
- 30 11. Apparatus for treating a product made of a material which has or materials which have been applied to a surface in a liquid form and thereafter have dried or cured to make the product ready for use, the apparatus comprising an impermeable sheet (18), means (20) for
- 35 securing the sheet to a surface (10) of the product to be treated to enclose a space between the surface and the

- 13 -

sheet, means (30,42) for holding the sheet (18) spaced from the surface to allow gas and vapour to be extracted from any area of the surface beneath the sheet, heating means (32) for applying heat within the space and means  
5 (38) for continuously extracting the gaseous contents of the space.

12. Apparatus as claimed in Claim 11, wherein the means for extracting the gaseous contents of the space is a  
10 vacuum pump (38) capable of working down to pressures of 5 to 2 mb Abs.

13. Apparatus as claimed in Claim 11 or Claim 12, wherein the heating means (32) includes a thermostat and a  
15 controller so that a constant temperature can be maintained within the space.

14. Apparatus as claimed in any one of Claims 11 to 13, wherein the sheet (18) has thermal insulation properties.  
20

15. Apparatus as claimed in any one of Claims 11 to 14, including sheets (10b, 10c, 10d, 10e) of differing sizes and differing shapes, so that the method can be carried out on product areas of various shapes.  
25

16. Apparatus as claimed in any one of Claims 11 to 15, wherein the edges of the sheet (18) are of a material which will form an air-tight seal against the surface when pulled against the surface by a vacuum.  
30

16. A method of treating a product moulded from fibre reinforced plastics, wherein impermeable sheet material (18) is secured to a surface (10) of the product to be treated to enclose a space between the surface and the  
35 layer, heating is applied within the space, and the gaseous contents of the space are continuously extracted.

# INTERNATIONAL COOPERATION TREATY

## PCT

### INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference <b>P2513.PC/DCC</b>	<b>FOR FURTHER ACTION</b> see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. <b>PCT/GB 99/ 03966</b>	International filing date (day/month/year) <b>29/11/1999</b>	(Earliest) Priority Date (day/month/year) <b>29/01/1999</b>
Applicant  <b>DAVEY, Terence, James</b>		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 4 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

#### 1. Basis of the report

a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,

☐ the text is approved as submitted by the applicant.

☒ the text has been established by this Authority to read as follows:

**METHOD OF TREATING FIBER-REINFORCED PLASTIC ARTICLES**

5. With regard to the **abstract**,

☐ the text is approved as submitted by the applicant.

☒ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.

☒ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

1

☐ None of the figures.

## INTERNATIONAL SEARCH REPORT

ernational application No.

PCT/GB 99/ 03966

### Box III TEXT OF THE ABSTRACT (Continuation of item 5 f the first sheet)

To treat FRP moulded products, such as boat hulls (10), where the structure of the FRP laminate has been damaged, eg by water penetration, a layer of impermeable sheet material (18) is first secured to a surface of the product to be treated to enclose a space between the surface and the layer. The contents of the space are continuously evacuated, for example by a vacuum pump (38), and then heating is applied within the space. A spacer (30) is provided within the space to hold the sheet material away from the surface when vacuum is applied.

## INTERNATIONAL SEARCH REPORT

International Application No.  
PCT/GB 99/03966

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B29C73/26 B29C73/32 //B63B9/00,B29L31:30

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B63B B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 2 693 147 A (KONIGS KARL;LEOBON HENRI; LEOBON LAURENT) 7 January 1994 (1994-01-07) page 9, line 30 - line 37; figure 3 page 10, line 1 -page 11, line 2 page 6, line 30 - line 37 ---	1,3-5, 11-19
X	US 3 837 965 A (MAHON J ET AL) 24 September 1974 (1974-09-24)  column 2, line 64 -column 3, line 10; figure 1 column 3, line 46 -column 4, line 17 ---	1,3-5,7, 11-13, 15-19
A	US 5 622 661 A (CEDERSTROEM ROLF V) 22 April 1997 (1997-04-22) the whole document --- -/--	1,8-11, 17

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

## ° Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance  
 "E" earlier document but published on or after the international filing date  
 "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)  
 "O" document referring to an oral disclosure, use, exhibition or other means  
 "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention  
 "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone  
 "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.  
 "&" document member of the same patent family

Date of the actual completion of the international search

20 April 2000

Date of mailing of the international search report

08/05/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
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 Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
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Authorized officer

Fregosi, A



## INTERNATIONAL SEARCH REPORT

International Application No  
PCT/GB 99/03966

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 236 646 A (COCHRAN ROLAND C ET AL) 17 August 1993 (1993-08-17) column 2, line 51 -column 3, line 10 -----	1,6,7, 11,17

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 99/03966

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
FR 2693147	A	07-01-1994	NONE	
US 3837965	A	24-09-1974	NONE	
US 5622661	A	22-04-1997	SE 506310 C	01-12-1997
			AT 165041 T	15-05-1998
			AU 5439494 A	08-06-1994
			DE 69318021 D	20-05-1998
			DE 69318021 T	26-11-1998
			EP 0646059 A	05-04-1995
			ES 2117978 T	01-09-1998
			JP 7506305 T	13-07-1995
			SE 9203358 A	11-05-1994
			WO 9411181 A	26-05-1994
US 5236646	A	17-08-1993	NONE	

## PCT

## REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No.

International Filing Date

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference  
(if desired) (12 characters maximum) P2513.PC/DCC

## Box No. I TITLE OF INVENTION

TREATMENT METHOD

## Box No. II APPLICANT

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

Davey, Terence James  
Journey's End  
Marsh Lane  
Felixstowe  
Suffolk  
IP11 9RR United Kingdom

☒ This person is also inventor.

Telephone No.

Facsimile No.

Teleprinter No.

State (that is, country) of nationality:  
GBState (that is, country) of residence:  
GB

This person is applicant for the purposes of: ☒ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

## Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

This person is:

☐ applicant only☐ applicant and inventor☐ inventor only (If this check-box is marked, do not fill in below.)

State (that is, country) of nationality:

State (that is, country) of residence:

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on a continuation sheet.

## Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:

☒ agent☐ common representative

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

Copp, David Christopher  
Dummett Copp  
25 The Square  
Martlesham Heath  
Ipswich,  
IP5 3SL, United Kingdom

Telephone No.

01473 660600

Facsimile No.

01473 660612

Teleprinter No.

☐ Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

**Box No.V DESIGNATION OF STATES**

The following designations are hereby made under Rule 4.9(a) (mark the applicable check-boxes; at least one must be marked).

**Regional Patent**

- ☒ **AP** ARIPO Patent: GH Ghana, GM Gambia, KE Kenya, LS Lesotho, MW Malawi, SD Sudan, SL Sierra Leone, SZ Swaziland, UG Uganda, ZW Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT
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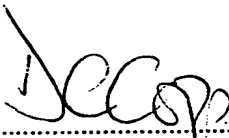
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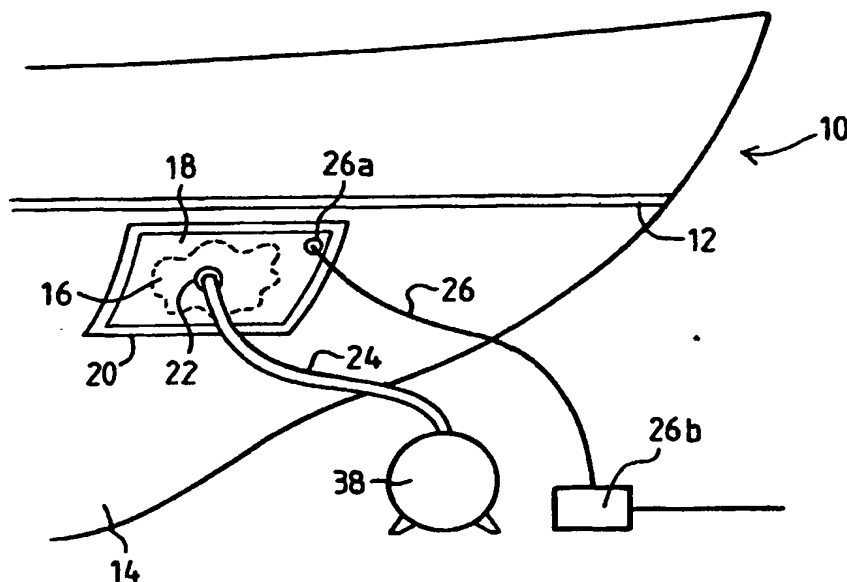
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(54) Title: METHOD OF TREATING FIBER-REINFORCED PLASTIC ARTICLES



(57) Abstract

To treat FRP moulded products, such as boat hulls (10), where the structure of the FRP laminate has been damaged, e.g. by water penetration, a layer of impermeable sheet material (18) is first secured to a surface of the product to be treated to enclose a space between the surface and the layer. The contents of the space are continuously evacuated, for example by a vacuum pump (38), and then heating is applied within the space. A spacer (30) is provided within the space to hold the sheet material away from the surface when vacuum is applied.

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## METHOD OF TREATING FIBER-REINFORCED PLASTIC ARTICLES

This invention relates to a method of and apparatus for treating products which are made of materials which are applied to a surface (which may be a mould surface which is subsequently removed) in a liquid form and thereafter have to dry or cure before the product is ready for use. Such materials will usually have a heterogenous structure. Examples of such products are those made from fibre reinforced plastics and plastered building walls, but the invention can have much wider application.

The invention is particularly suited for treating glass fibre boat hulls, but is not limited to this particular application. For convenience, the invention will largely be described with reference to its application to boat hulls but this is not to be taken as limiting the application of the invention, and those skilled in the art will be able to adapt the teaching here for use in connection with other products or structures.

Fibre reinforced plastics (FRP) boat hulls conventionally have a smooth outer gelcoat layer and a structural layer made up of fibres (usually glass fibres) embedded in a resin (most usually polyester resin). In some cases a foam or timber core is encapsulated between two reinforced fibre layers. The gelcoat and resin are initially liquids which are mixed with a hardener (catalyst) and applied within a mould in liquid state. After application, the liquids cure to the solid state.

After prolonged exposure in a marine environment, a number of boat hulls are found to suffer blistering which appears on the outer gelcoat surface. It appears that this is caused by a build up of fluid between the gelcoat layer

and the fibre/resin layer. The damage can result from one or more of the following: water penetration; degradation reactions resulting from water penetration; deterioration resulting from faulty manufacture; deterioration resulting from faulty materials used in the moulding process; deterioration resulting from failed bonding or de-lamination of foam or timber cores; de-lamination of the moulding. The symptoms of such damage are often attributed to "osmosis" but there is some doubt as to whether any or all of this damage is actually caused by an osmotic reaction.

Conventional treatment is to remove the affected gelcoat to expose the underlying fibre/resin lay-up, to thoroughly dry the exposed fibre/resin lay-up and then when drying is complete to reinstate the gelcoat, possibly with the addition of different resins to provide a better moisture barrier.

This treatment is sometimes, but by no means always, successful. It does however take a considerable amount of time because the resin/fibre lay-up can only be dried slowly, usually by allowing it to stand in the open.

According to the present invention, there is provided a method of treating a product moulded from fibre reinforced plastics, wherein the edges of a sheet of impermeable sheet material are secured to a surface of the product to be treated to enclose a space between the surface and the sheet, heating is applied within the space, and the gaseous contents of the space are continuously extracted while the sheet is held spaced from the surface to allow gas and vapour to be extracted from any area of the surface beneath the sheet.

The heating is preferably applied from a heat source within the space, but may also be applied from an external heat source, provided there is a thermally conducting path into the space, eg through a thermally conductive impermeable sheet material. In any case, some heat loss through the sheet material is desirable as this helps to maintain an even heat distribution within the space.

Preferably the sheet material has an area of up to 1 m<sup>2</sup>, and can be of any convenient shape. The material is preferably secured to a part only of the product surface, and the entire product surface is preferably treated in a batch-wise manner by treating all the parts of the surface sequentially, or by securing a plurality of sheets simultaneously to different parts of the surface. Using a piece or pieces of sheet material of this size allows a boat hull to be treated section-by-section

The method will generally be carried out after the affected gelcoat, and any physically damaged material has been removed from the surface.

To maintain the space between the sheet and the surface, a permeable, substantially non-compressible spacer layer is preferably positioned between the sheet and the surface.

Extraction of the gaseous contents to form a vacuum (this term includes a partial vacuum) behind the sheet will pull the sheet against the spacer layer and (around the sheet edges) against the surface of the product to be treated to enclose a space adjacent the surface. It may be useful to initially secure the sheet to the surface by adhesive mastic or tape around the edges of the sheet to hold the sheet in place until the vacuum is applied. If there are any leaks around the edge of the sheet preventing the

maintenance of a suitable vacuum, adhesive tape or some other form of sealant may be applied around the edges.

5 The edges of the sheet may be of a soft, impermeable material which will be drawn against the surface when a vacuum is applied to form a seal without the need for any additional tape or sealant, or may have such a material sealed to the sheet edges.

10 A vacuum pump can be connected to the space to provide the extraction facility.

15 Tests have shown that the damage to the hull or other product does not only result from water penetration through the gelcoat, but also from unreacted chemicals in the gelcoat and in the fibre/resin layers. In some cases the resin is not completely cured at the time of manufacture, leading to the presence of reactive, but unreacted, chemicals in the structure.

20 By heating the laminate from the surface at the same time as drawing off any vapour or moisture from the surface, it is possible to ensure that any unreacted chemicals complete their reaction so that they become stable, at the same time as producing the necessary drying of the  
25 moulding. Once the drying is completed in this way, the removed gelcoat can be replaced with fresh gelcoat and the hull can be finished to complete the repair.

30 It is preferred to produce a vacuum in the space to a level of about 2 - 5 mb Abs, before beginning to apply heat within the space.

35 It is preferred to heat the surface within the space to a temperature which is just below the temperature at which

the moulding will be damaged by excess heat. In the case of polyester resins, the surface may be heated to a temperature between 80°C and 90°C which is a temperature at which the surface will not be at risk from damage caused by the elevated temperature. The elevated temperature however is effective in producing post-cure of any unreacted chemicals in the laminate. Higher temperatures may be used when the damage/deterioration is severe.

10 By continuously applying a very low pressure (high vacuum) to the space, vapour or gas is drawn off as soon as it becomes free at the surface, and also any gaseous reaction products are drawn off so that reactions take place quickly and thoroughly.

15 The invention also provides apparatus for treating a product moulded from fibre reinforced plastics, the apparatus comprising an impermeable sheet, means for securing the sheet to a surface of the product to be  
20 treated to enclose a space between the surface and the sheet, means for holding the sheet spaced from the surface to allow gas and vapour to be extracted from any area of the surface beneath the sheet, heating means for applying heat within the space and means for continuously  
25 extracting the gaseous contents of the space.

The means for spacing the sheet from the surface ensures that a space is maintained between the sheet and the surface, even when vacuum is applied. The spacing means  
30 may also space the heating means from the surface.

The means for extracting the gaseous contents of the space is preferably a vacuum pump capable of working down to pressures of 5 to 2 mb Abs.

The heating means preferably includes a thermostat and a controller so that a constant temperature can be maintained within the space. The sheet may include thermal insulating material.

5

A treatment duration of about 1-2 hours may be sufficient to dry out an area of laminate about 0.5 m<sup>2</sup>.

10 The apparatus may include sheets of differing sizes and differing shapes, so that the method can be carried out on product areas of various shapes.

The invention will now be further described, by way of example, with reference to the accompanying drawings, in  
15 which:

Figure 1 shows a boat hull being treated by a method in accordance with the invention;

20 Figures 2, 3, 4 and 5 show impermeable sheets of various different shapes;

Figure 6 is a cross section through one form of apparatus in accordance with the invention;

25

Figure 7 is a cross section through a second form of apparatus in accordance with the invention; and

30 Figures 8a and 8b show details of an edge of the apparatus before and after application of vacuum.

Figure 1 shows a yacht hull 10 with a water line 12 and a  
35 keel 14. A damaged area of the hull is shown in dotted

lines at 16, and this area has been covered by an impervious sheet or mat 18 which is secured to the hull 10 all the way round by adhesive tape 20, or by a suitable mastic. Alternatively the sheet may have an edge of a material which will automatically form a seal when pulled against the surface by a vacuum. Thus the space between the hull and the sheet 18 is enclosed. A suitable material for the sheet is a silicone rubber.

10 Connected to the centre of the sheet 18 is an outlet 22 for a vacuum hose 24. Also connected to the sheet 18 is an electrical lead 26 which leads from a power supply 26b through a connection 26a to a heating element attached to the surface of the sheet 18 which will face the hull.

15

Figure 6 shows a cross section through the area covered by the sheet 18. A layer of permeable insulating material 30 (for example a non-woven permeable polyester blanket) is provided immediately underneath the sheet 18, and a heating element 32 is sandwiched between two heat resisting permeable layers 34, 36. The heating element 32 is connected to the electrical supply 26. In use, when suction is applied through the outlet 22, air and any other gaseous elements contained within the space beneath the sheet 18 will be sucked out. This will tend to pull the sheet 18 against the surface of the hull 10, but a spacing will still be maintained because of the presence of the permeable spacer 30, and because the heating element 32 itself is substantially incompressible and occupies space. As a result, the pump 38 will be able to draw off gas from the whole of the space beneath the sheet 18, and thus from all parts of the surface of the hull 10 which are exposed within the space.

Other parts of the hull can be treated at the same time by securing other sheets as described to the appropriate hull parts. One vacuum pump may serve to simultaneously evacuate several areas under treatment.

5

The heating element 32 is sandwiched between the layers 34 and 36, partly to protect the heating element itself and partly to avoid scorching the surface of the hull 10. However it is possible for the heating element to be in  
10 direct contact with the hull if the temperature of the heating element and the surface of the hull are compatible. The element 32 can be sewn to one or the other of the layers 34,36.

15 A thermostat 40 can be fitted in a position where it will be in contact with the hull surface 10 so that the hull temperature can be monitored.

The arrangement shown in Figure 6 provides a very flexible  
20 device which can follow complex hull contours. Figure 7 shows a somewhat less flexible alternative. In this alternative, instead of the permeable insulating spacer 30, a wire mesh spacer 42 is used, and in this case the spacer 42 lies against the hull surface and the heating  
25 element is fitted between the sheet 18 and the spacer. The wire mesh spacer 42 has flexibility, but less than that of the insulating sheet type spacer 30 of Figure 6.

As the hulls of boats are irregular shapes, and parts of  
30 the hull, for example close to the bow, may need to be treated, it may be useful to have sheets of different shapes.

Figure 2 shows a simple rectangular sheet 10b with rounded  
35 corners; Figure 3 a round sheet 10c; Figure 4 a triangular



sheet 10d and Figure 5 a long narrow sheet 10e. The sheet of Figure 5 can be used for example to treat areas of a hull between chines. The rounded corners of Figure 2 allow a single strip of mastic to be easily placed all the way around the edges of the sheet, thus avoiding air gaps. The other sheet shapes can also have rounded corners.

In use, a strip of adhesive mastic tape 20 (Figure 8a) is stuck to the edges of the sheet 18, and the sheet is secured to the damaged area of the hull (after removal of the damaged gelcoat) by this tape. A high vacuum is applied to the surface of the hull through the conforming flexible enclosure which has an underlying permeable spacer. The edges of the sheet are pulled down against the hull with the result that the tape 20 is compressed, as can be seen in Figure 8b. However the presence of the spacer 30, 42 ensures that there is always communication between the outlet 22 and all parts of the hull surface beneath the sheet. Heat is then slowly applied to raise the laminate to that temperature where the contaminants made volatile by the low pressure are drawn off.

The heater is equipped with a controller which maintains a steady temperature at which the moulding is likely to be completely cured or stabilised. The heat output is controlled to remain safely below the temperature at which the laminate would be damaged or affected by a serious loss of structural strength.

The temperature at which the laminate is maintained varies with the materials of the moulding. For example, a typical glass fibre reinforced polyester moulding would be maintained at a temperature between 82°C and 90°C.

After completion of treatment, the heater is switched off, the vacuum is released and the sheet is removed by peeling it away from the surface. The mastic tape 20 is removed and discarded. Before the sheet is applied to a new area of the surface, a fresh layer of tape is applied around the sheet edge.

The method and apparatus allows large mouldings to be effectively treated by means of moderately sized, easily handled enclosures. Although the technique has been particularly developed for use on boat hulls, it can also be used on other mouldings, for example fixed mouldings used in architecture, tanks or containments.

It has been found that glassfibre structures, treated in this way, experience some change in mechanical properties. It has surprisingly been found that treated structures have a greater stiffness in bending after treatment than before, while a small decrease in tensile strength has been noted. For boat hulls, stiffness in bending is important as this reduces flexing of the hull in a seaway.

The vacuum at which the system is effective depends upon the defects in the moulding. However the method is more efficient as the vacuum increases. Typical vacuum levels are close to 2.0 Mb absolute.

The combination of heat and vacuum, applied as described here will be sufficient to stabilise the deteriorating fibre/resin structure and allow restoration to its original condition. Thus, whether the problem is simply water penetration, or a more chemically complex problem, a solution can still be achieved.

## Claims

1. A method of treating a product which is made of a material which has or materials which have been applied to a surface in a liquid form and thereafter have dried or cured to make the product ready for use, wherein the edges of a sheet of impermeable sheet material are secured to a surface of the product to be treated to enclose a space between the surface and the sheet, heating is applied within the space, and the gaseous contents of the space are continuously extracted while the sheet is held spaced from the surface to allow gas and vapour to be extracted from any area of the surface beneath the sheet.
2. A method as claimed in Claim 1, wherein the impermeable sheet material is secured to the surface by adhesive tape around the edges of the material, so that a space is provided between the impermeable sheet material and the surface.
3. A method as claimed in Claim 1 or Claim 2, wherein the impermeable sheet material has edges which are capable of forming an air tight seal when pulled against the surface by a vacuum.
4. A method as claimed in any preceding claim, wherein a vacuum pump is connected to the space to provide the extraction facility.
5. A method as claimed in any preceding claim, wherein a vacuum is produced in the space before beginning to apply heat within the space.

6. A method as claimed in any preceding claim, wherein a vacuum at a level of about 2 - 5 mb Abs is produced and maintained in the space.

5 7. A method as claimed in any preceding claim, wherein the product is a glassfibre moulding made with a polyester resin and the surface within the space is heated to a temperature of between 80°C and 90°C.

10 8. A method as claimed in any preceding claim, wherein the product is a glassfibre moulding with an outer gelcoat and wherein the sheet material is secured to the surface after affected gelcoat, and any physically damaged material has been removed from the surface.

15 9. A method as claimed in Claim 8, wherein the treatment is completed by replacing removed gelcoat with fresh gelcoat.

20 10. A method of treating a boat hull moulded from fibre reinforced plastics, wherein the edges of a sheet of impermeable sheet material are secured to a surface of the hull to be treated to enclose a space between the surface and the sheet, heating is applied within the space, and  
25 the gaseous contents of the space are continuously extracted while the sheet is held spaced from the surface to allow gas and vapour to be extracted from any area of the surface beneath the sheet.

30 11. Apparatus for treating a product made of a material which has or materials which have been applied to a surface in a liquid form and thereafter have dried or cured to make the product ready for use, the apparatus comprising an impermeable sheet, means for securing the  
35 sheet to a surface of the product to be treated to enclose

a space between the surface and the sheet, means for holding the sheet spaced from the surface to allow gas and vapour to be extracted from any area of the surface beneath the sheet, heating means for applying heat within the space and means for continuously extracting the gaseous contents of the space.

12. Apparatus as claimed in Claim 11, wherein the means for extracting the gaseous contents of the space is a vacuum pump capable of working down to pressures of 5 to 2 mb Abs.

13. Apparatus as claimed in Claim 11 or Claim 12, wherein the heating means includes a thermostat and a controller so that a constant temperature can be maintained within the space.

14. Apparatus as claimed in any one of Claims 11 to 13, wherein the sheet has thermal insulation properties.

15. Apparatus as claimed in any one of Claims 11 to 14, including sheets of differing sizes and differing shapes, so that the method can be carried out on product areas of various shapes.

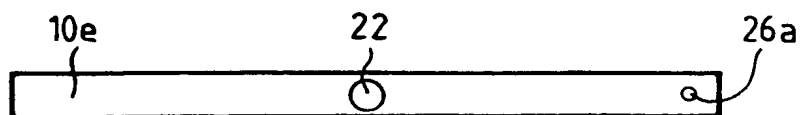
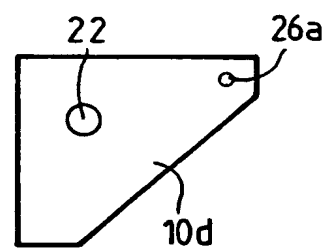
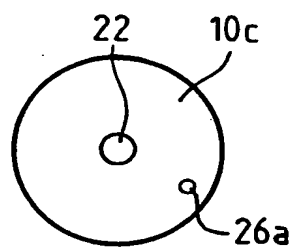
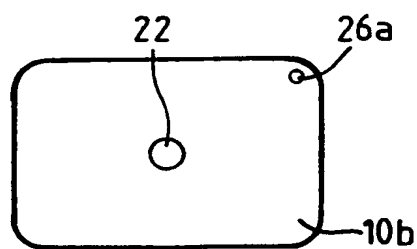
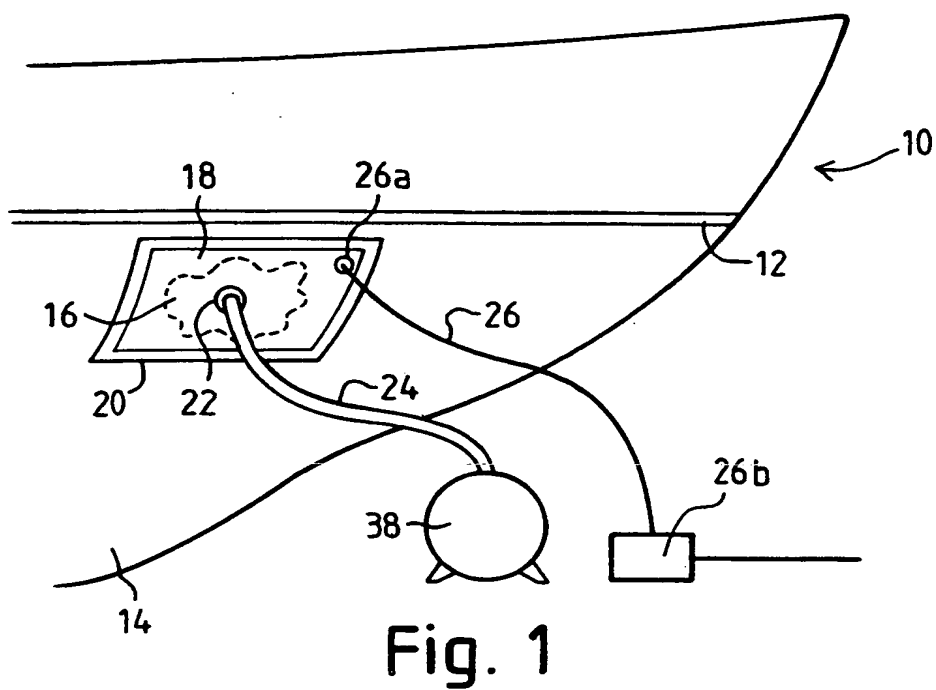
16. Apparatus as claimed in any one of Claims 11 to 15, wherein the edges of the sheet are of a material which will form an air-tight seal against the surface when pulled against the surface by a vacuum.

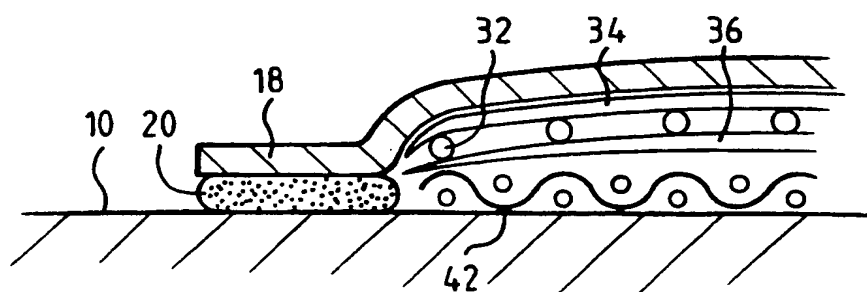
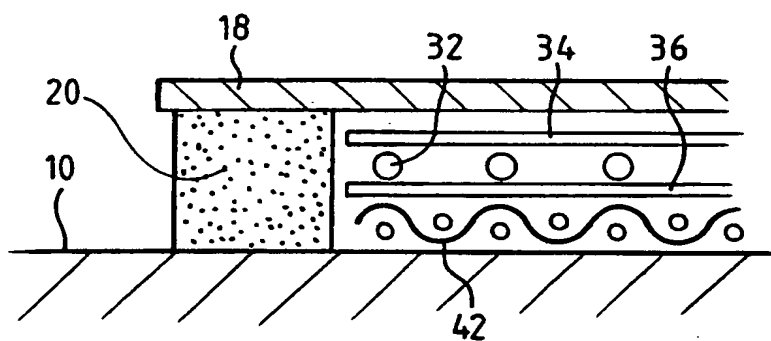
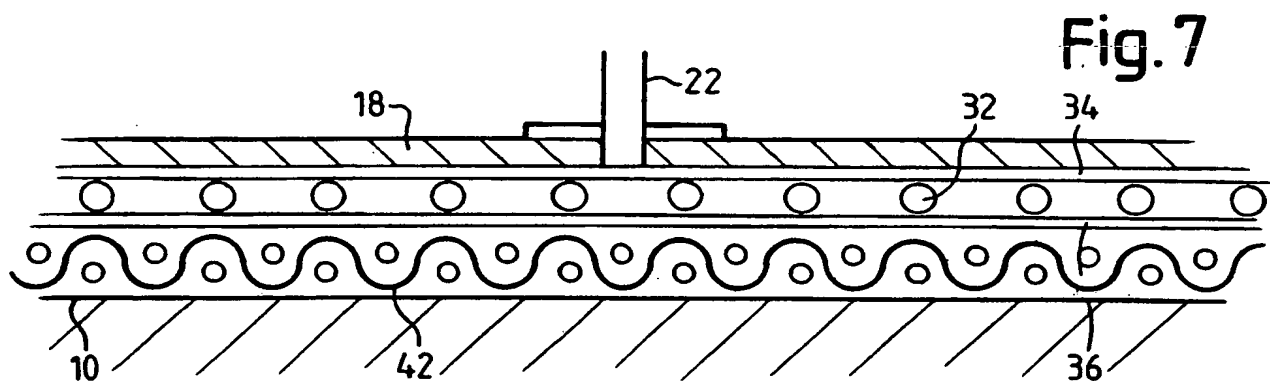
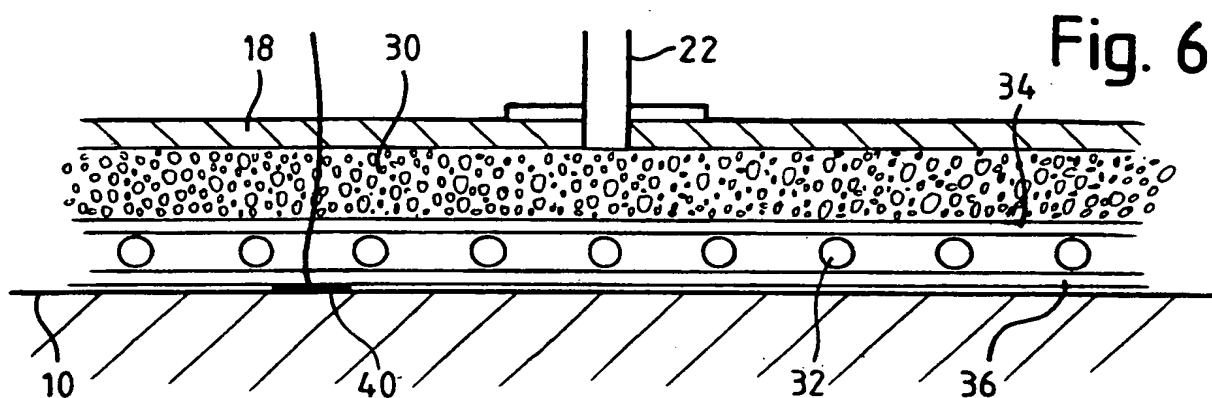
16. A method of treating a product moulded from fibre reinforced plastics, wherein impermeable sheet material is secured to a surface of the product to be treated to enclose a space between the surface and the layer, heating

is applied within the space, and the gaseous contents of the space are continuously extracted.

17. A method of treating a product moulded from fibre  
5 reinforced plastics, substantially as herein described  
with reference to the accompanying drawings

18. Apparatus for treating a product moulded from fibre  
reinforced plastics substantially as herein described with  
10 reference to the accompanying drawings







# INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 99/03966

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B29C73/26 B29C73/32 //B63B9/00,B29L31:30

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B63B B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 2 693 147 A (KONIGS KARL;LEOBON HENRI; LEOBON LAURENT) 7 January 1994 (1994-01-07) page 9, line 30 - line 37; figure 3 page 10, line 1 -page 11, line 2 page 6, line 30 - line 37 ---	1,3-5, 11-19
X	US 3 837 965 A (MAHON J ET AL) 24 September 1974 (1974-09-24)  column 2, line 64 -column 3, line 10; figure 1 column 3, line 46 -column 4, line 17 ---	1,3-5,7, 11-13, 15-19
A	US 5 622 661 A (CEDERSTROEM ROLF V) 22 April 1997 (1997-04-22) the whole document --- -/--	1,8-11, 17

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

20 April 2000

Date of mailing of the international search report

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# INTERNATIONAL SEARCH REPORT

International Application No

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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